US009301312B2

(12) **United States Patent**
Eidenschink

(10) **Patent No.: US 9,301,312 B2**
(45) **Date of Patent: *Mar. 29, 2016**

(54) **NETWORK ACCELERATOR FOR CONTROLLED LONG DELAY LINKS**

(71) Applicant: **ViaSat, Inc.**, Carlsbad, CA (US)

(72) Inventor: **Thomas Eidenschink**, Carlsbad, CA (US)

(73) Assignee: **ViaSat, Inc.**, Carlsbad, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 127 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/221,975**

(22) Filed: **Mar. 21, 2014**

(65) **Prior Publication Data**

US 2014/0313971 A1 Oct. 23, 2014

Related U.S. Application Data

(63) Continuation of application No. 13/719,104, filed on Dec. 18, 2012, now Pat. No. 8,719,409, which is a continuation of application No. 12/830,188, filed on Jul. 2, 2010, now Pat. No. 8,359,387, which is a

(Continued)

(51) **Int. Cl.**

G06F 15/173 (2006.01)
H04W 4/00 (2009.01)

(Continued)

(52) **U.S. Cl.**

CPC ***H04W 72/10*** (2013.01); ***H04B 7/18513*** (2013.01); ***H04L 41/0896*** (2013.01); ***H04L 47/70*** (2013.01); ***H04L 47/822*** (2013.01); ***H04L 65/1036*** (2013.01); ***H04L 67/02*** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC H04L 12/40065; H04L 2012/5631–2012/5632; H04L 27/32–27/3405; H04L 2012/56; H04L 47/00–47/829; H04W 74/00–74/008; H04B 7/1851–7/18519

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,208,640	B1	3/2001	Spell et al.
6,282,542	B1	8/2001	Carneal et al.

(Continued)

FOREIGN PATENT DOCUMENTS

WO	2006/055944 A2	5/2006	

OTHER PUBLICATIONS

Extended European Search Report of Mar. 1, 2012 for European Patent Application No. EP05825156; 10 pages.

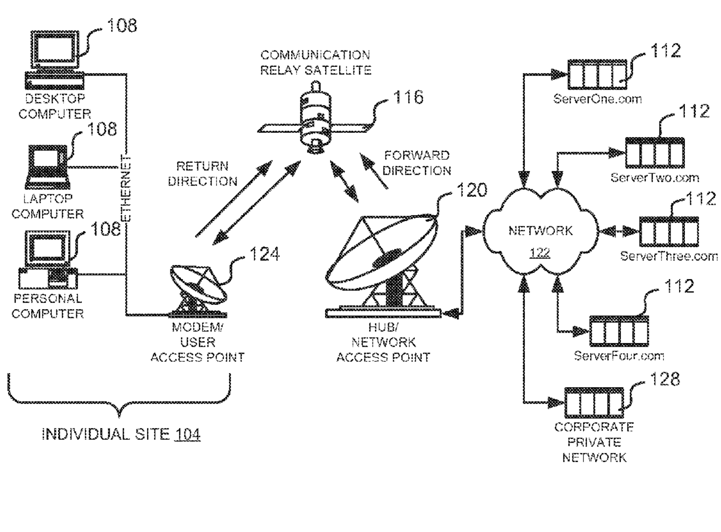
(Continued)

Primary Examiner — Brendan Higa
(74) *Attorney, Agent, or Firm* — Kilpatrick Townsend & Stockton LLP

(57) **ABSTRACT**

A communication system for providing network access over a shared communication link is disclosed. The communication system includes a user access point, a network access point and a communications link. The user access point is coupled to one or more user terminals that access a remote network. The network access point is coupled to the remote network. The communications link couples the user access point and the network access point. The communications link is at least partially controlled by the network access point, which monitors information passed between the remote network and the user access point to create an estimate of future usage of the communications link by the user access point based on the information. The network access point allocates communications link resources for the user access point based on the estimate.

18 Claims, 5 Drawing Sheets



Related U.S. Application Data

continuation of application No. 11/282,359, filed on Nov. 17, 2005, now Pat. No. 7,769,863.

(60) Provisional application No. 60/629,817, filed on Nov. 19, 2004.

(51) **Int. Cl.**

H04B 7/185	(2006.01)
H04W 72/10	(2009.01)
H04W 74/00	(2009.01)
H04L 12/24	(2006.01)
H04L 29/06	(2006.01)
H04L 29/08	(2006.01)
H04L 12/70	(2013.01)
H04L 12/911	(2013.01)

(52) **U.S. Cl.**

CPC ***H04L 67/28*** (2013.01); ***H04L 67/2819*** (2013.01); ***H04L 67/322*** (2013.01); ***H04L 69/24*** (2013.01); ***H04W 74/004*** (2013.01); *H04L 47/781* (2013.01); *H04L 47/824* (2013.01); *H04L 2012/5608* (2013.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,463,454	B1	10/2002	Lumelsky et al.
7,116,682	B1	10/2006	Waclawsky et al.
7,769,863	B2	8/2010	Eidenschink
8,359,387	B2	1/2013	Eidenschink
8,719,409	B2	5/2014	Eidenschink
2001/0011300	A1	8/2001	Pitts
2001/0043617	A1	11/2001	McKinnon et al.
2001/0048670	A1	12/2001	Kelly et al.
2001/0053152	A1	12/2001	Sala et al.
2003/0027522	A1	2/2003	Valdivia et al.
2003/0081626	A1	5/2003	Naor et al.
2003/0123394	A1	7/2003	Neale et al.
2003/0212787	A1	11/2003	Qiu et al.
2005/0026621	A1	2/2005	Febvre et al.
2005/0163059	A1	7/2005	Dacosta et al.
2005/0254426	A1	11/2005	Simonis
2006/0020700	A1	1/2006	Qiu et al.
2006/0034167	A1	2/2006	Grice et al.
2006/0109788	A1	5/2006	Eidenschink
2006/0120282	A1	6/2006	Carlson et al.
2013/0132585	A1	5/2013	Eidenschink

OTHER PUBLICATIONS

International Preliminary Report on Patentability of May 22, 2007 and Written Opinion for PCT Patent Application No. PCT/US2005/42244, 4 pages.

International Search Report of Nov. 29, 2006 for PCT Patent Application No. PCT/US2005/42244, 3 pages.

Non-Final Office Action of Jan. 9, 2009 for U.S. Appl. No. 11/282,359, 16 pages.

Final Office Action of Jul. 16, 2009 for U.S. Appl. No. 11/282,359, 17 pages.

Notice of Allowance of Mar. 24, 2010 for U.S. Appl. No. 11/282,359, 17 pages.

Non-Final Office Action of Jul. 26, 2012 for U.S. Appl. No. 12/830,188, 9 pages.

Notice of Allowance of Sep. 19, 2012 for U.S. Appl. No. 12/830,188, 6 pages.

Non-Final Office Action of Sep. 5, 2013 for U.S. Appl. No. 13/719,104, 15 pages.

Notice of Allowance of Dec. 23, 2013 for U.S. Appl. No. 13/719,104, 6 pages.

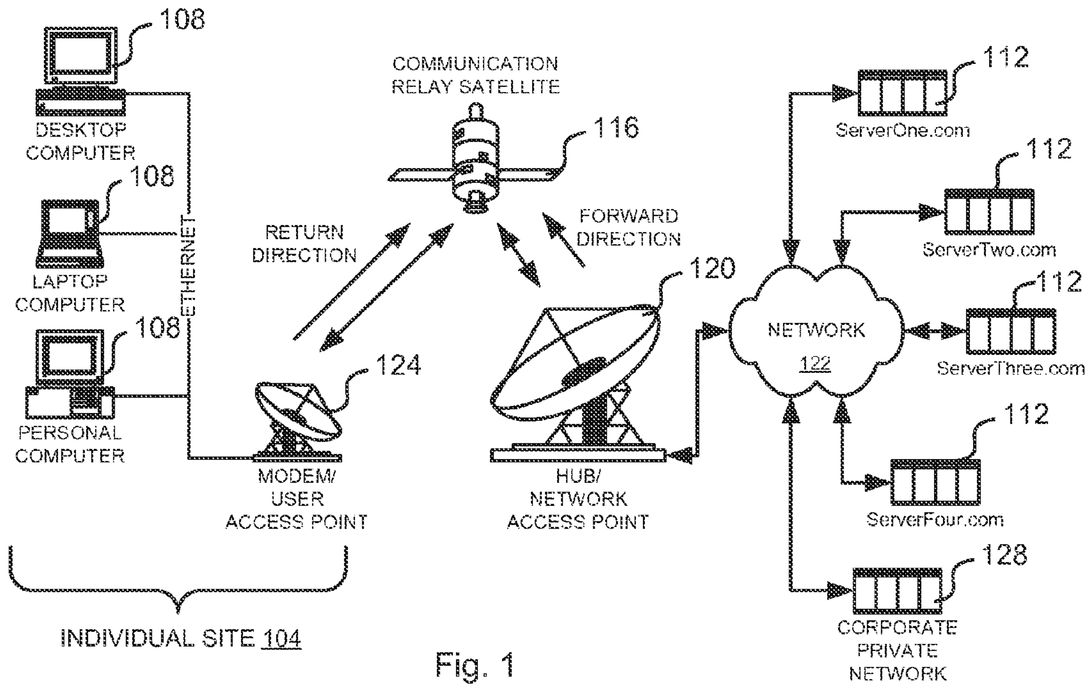

108
DESKTOP COMPUTER
108
LAPTOP COMPUTER
108
PERSONAL COMPUTER
ETHERNET
COMMUNICATION RELAY SATELLITE
116
RETURN DIRECTION
FORWARD DIRECTION
124
MODEM/ USER ACCESS POINT
120
HUB/ NETWORK ACCESS POINT
NETWORK 122
112
ServerOne.com
112
ServerTwo.com
112
ServerThree.com
112
ServerFour.com
128
CORPORATE PRIVATE NETWORK
INDIVIDUAL SITE 104

Fig. 1

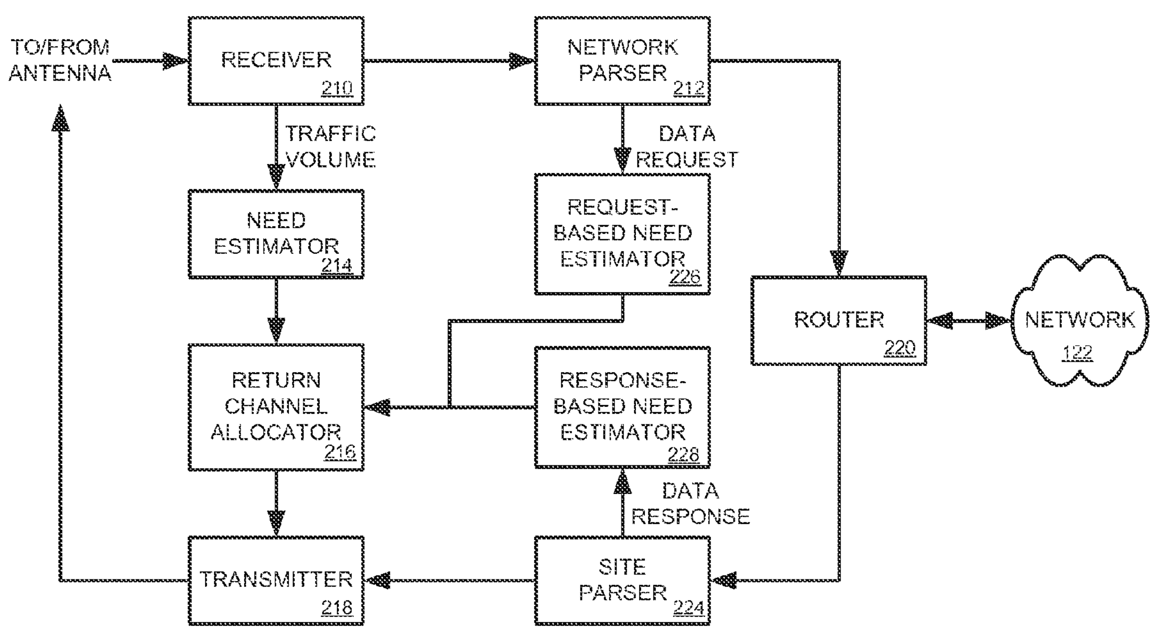

TO/FROM ANTENNA
RECEIVER 210
NETWORK PARSER 212
TRAFFIC VOLUME
DATA REQUEST
NEED ESTIMATOR 214
REQUEST-BASED NEED ESTIMATOR 226
ROUTER 220
NETWORK 122
RETURN CHANNEL ALLOCATOR 216
RESPONSE-BASED NEED ESTIMATOR 228
DATA RESPONSE
TRANSMITTER 218
SITE PARSER 224

Fig. 2

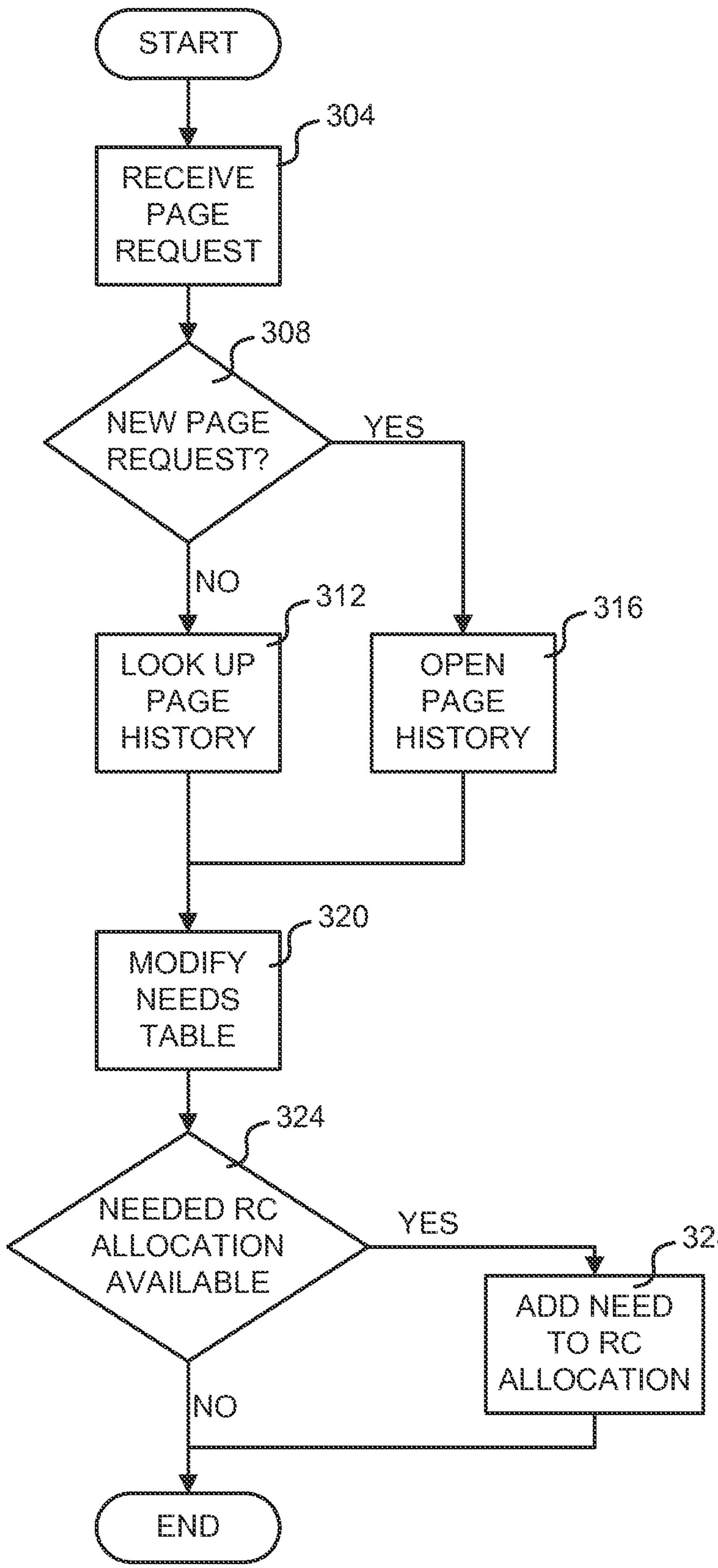

START
RECEIVE PAGE REQUEST
304
NEW PAGE REQUEST?
308
YES
NO
LOOK UP PAGE HISTORY
312
OPEN PAGE HISTORY
316
MODIFY NEEDS TABLE
320
NEEDED RC ALLOCATION AVAILABLE
324
YES
ADD NEED TO RC ALLOCATION
328
NO
END

Fig. 3

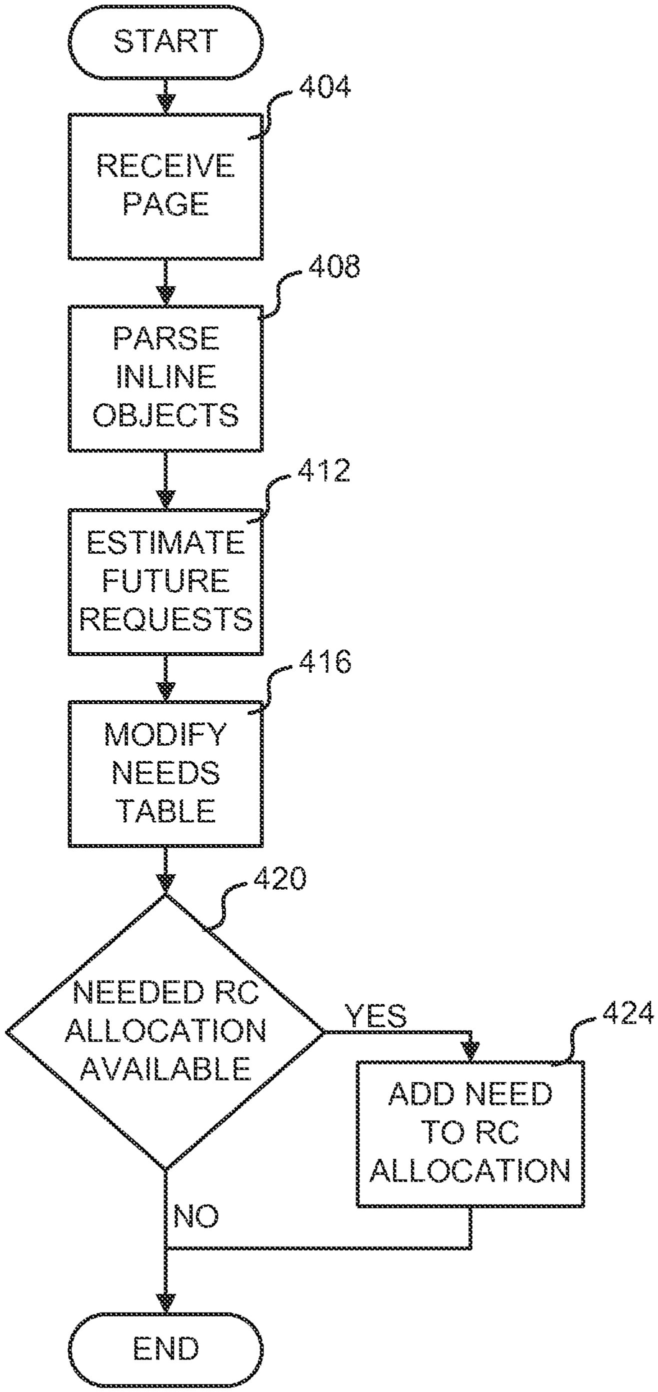

START
404
RECEIVE PAGE
408
PARSE INLINE OBJECTS
412
ESTIMATE FUTURE REQUESTS
416
MODIFY NEEDS TABLE
420
NEEDED RC ALLOCATION AVAILABLE
YES
424
ADD NEED TO RC ALLOCATION
NO
END

Fig. 4

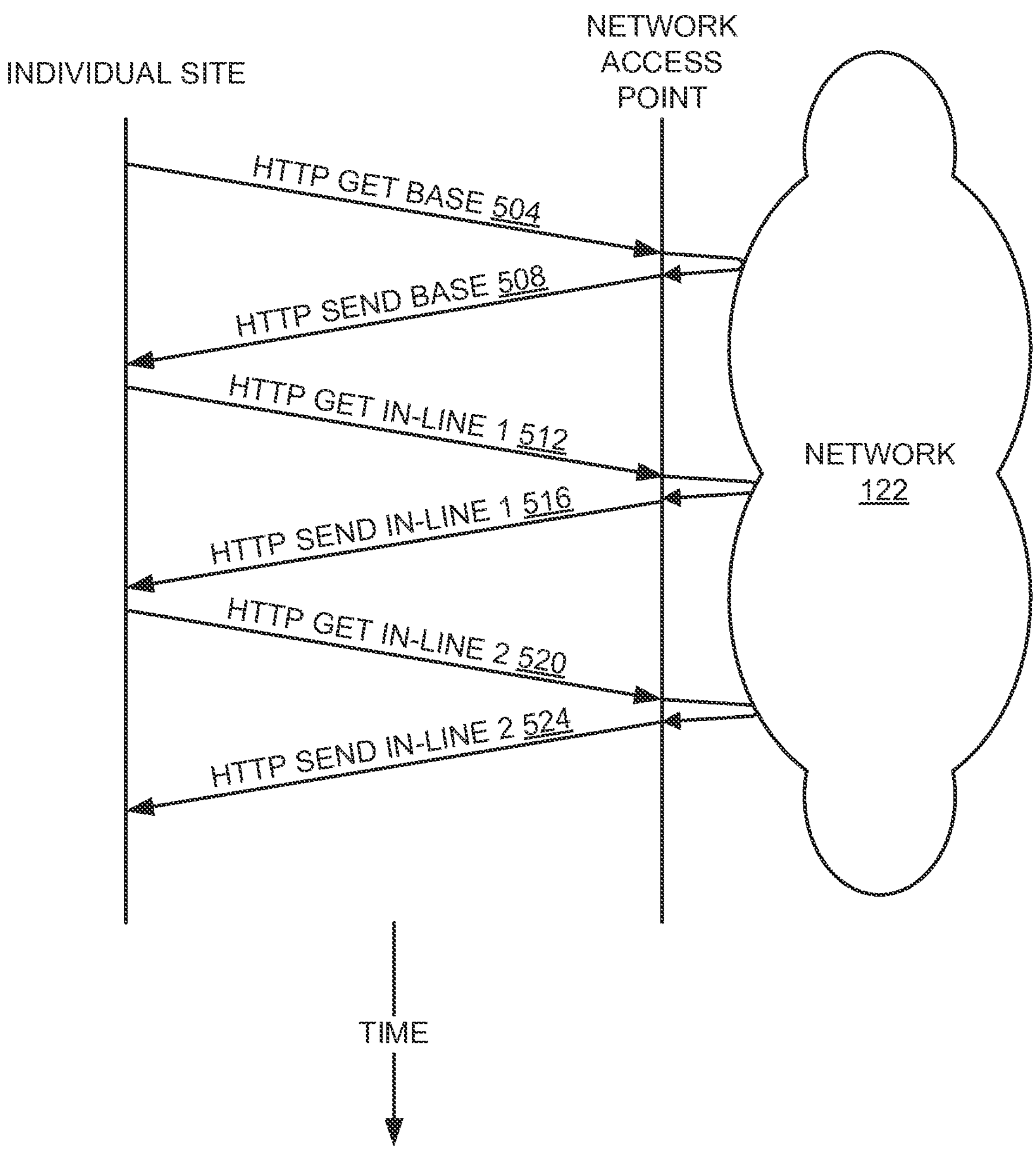


Fig. 5
Prior Art

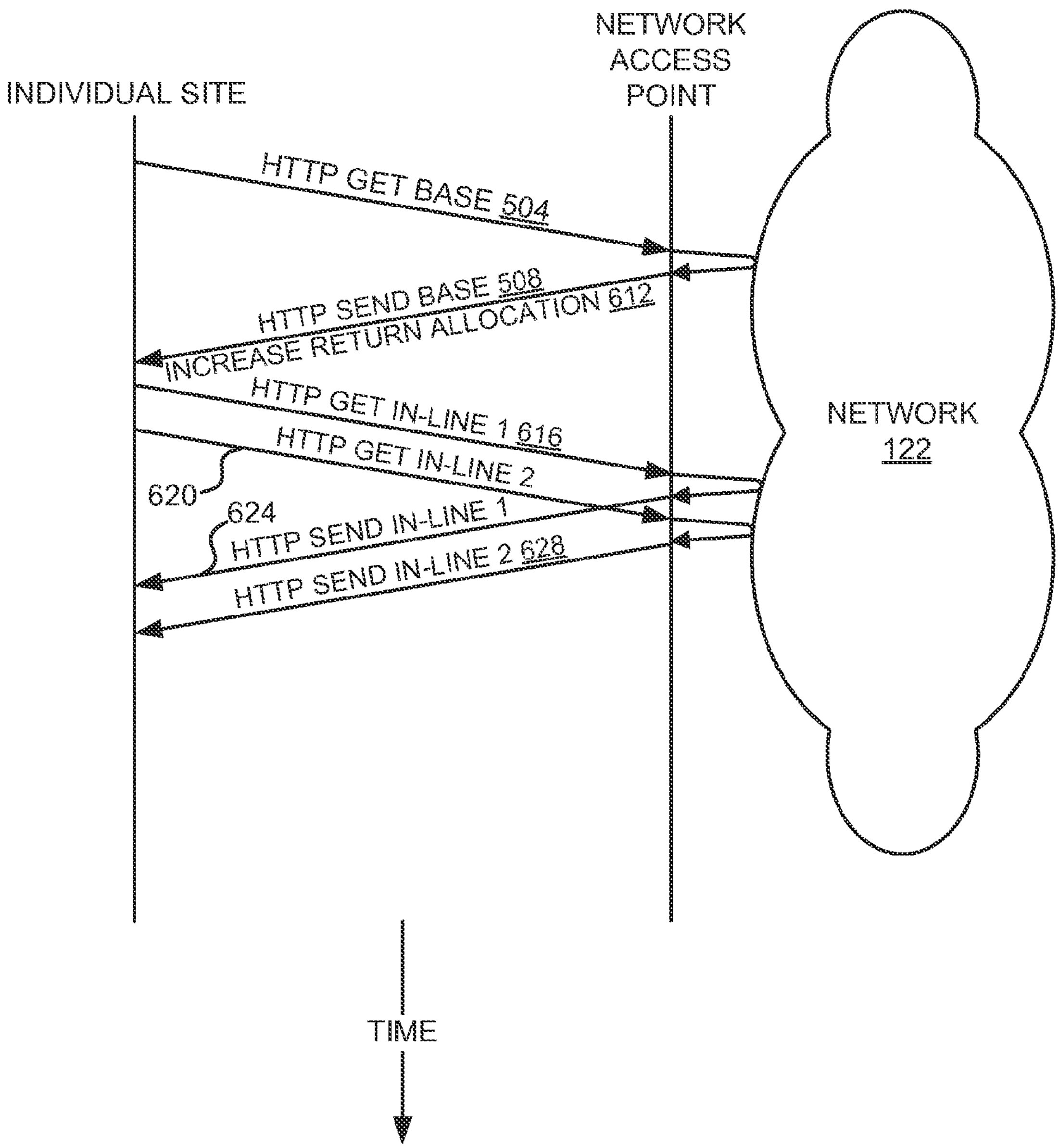

NETWORK
ACCESS
POINT
INDIVIDUAL SITE
HTTP GET BASE 504
HTTP SEND BASE 508
INCREASE RETURN ALLOCATION 612
HTTP GET IN-LINE 1 616
HTTP GET IN-LINE 2
620
624
HTTP SEND IN-LINE 1
HTTP SEND IN-LINE 2 628
NETWORK
122
TIME

Fig. 6

NETWORK ACCELERATOR FOR CONTROLLED LONG DELAY LINKS

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a continuation of U.S. Nonprovisional application Ser. No. 13/719,104, filed Dec. 18, 2012, which is a continuation of U.S. Nonprovisional application Ser. No. 12/830,188, filed Jul. 2, 2010, which is a continuation of U.S. Nonprovisional application Ser. No. 11/282,359, filed Nov. 17, 2005, which claims the benefit of U.S. Provisional Application No. 60/629,817, filed Nov. 19, 2004, the entire contents of which are incorporated herein by reference in their entirety for all purposes.

BACKGROUND

This disclosure relates in general to networking and, more specifically, but not by way of limitation, to networking over controlled long delay links.

Network access via satellite link has many speed limitations imposed by the long time delay of the link. Since the bulk of the Internet is composed of landline and short wireless links, communication delay has traditionally been associated with either slow or congested links. This bias has translated into standard protocols that create typical delays for satellite users that are much longer than just the sum of the typical landline delay plus the inherent satellite transmission delay.

Since one of the main uses for the Internet is web browsing, much effort has been done to speed up the loading of web pages over long delay links. For example, "*A Smart Internet Caching System*" Dias, et al., Internet Society NET 1996, is directed toward the acceleration of web browsing by the use of an intelligent agent at a distant (in terms of transmission time) gateway. One function of this agent is to observe base pages as they come from web servers and pre-fetch any in-line files (for example, images) that are referred to in the base page. These files are then pushed across the long delay link to be cached for immediate access by the user upon request. Although this method can be employed on satellite links, it has serious limitations because of the overhead involved and the possibility of pushing unneeded information over the long delay link. For example, if a user is loading the home page for a shopping server, the home page may be customized to that user. In this case, the link resources would be wasted loading generic in-line elements that do not apply to the current user. As well, locally running web applications such as Java are not well served by a pre-fetching technique.

BRIEF SUMMARY

In one embodiment, the present disclosure provides a communication system for providing network access over a shared communication link. The communication system includes a user access point, a network access point and a communications link. The user access point is coupled to one or more user terminals that access a remote network. The network access point is coupled to the remote network. The communications link couples the user access point and the network access point. The communications link is at least partially controlled by the network access point, which monitors information passed between the remote network and the user access point to create an estimate of future usage of the communications link by the user access point based on the information. The network access point allocates communications link resources for the user access point based on the estimate.

Further areas of applicability of the present disclosure will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating various embodiments, are intended for purposes of illustration only and are not intended to necessarily limit the scope of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure is described in conjunction with the appended figures:

FIG. **1** is a schematic representation of the environment of the network accelerator system according to the present disclosure.

FIG. **2** is a high level block diagram of an embodiment of a portion of a hub that is relevant to the description of the disclosure.

FIG. **3** is an exemplary flow chart of the operation of the disclosure of a gateway function.

FIG. **4** is a flow chart of another embodiment of the operation of the disclosure of the gateway.

FIG. **5** is a data flow diagram depicting a transaction in which conventional techniques are used to obtain a base HTTP page with two in-line elements.

FIG. **6** depicts the same transaction as FIG. **5**, except in this scenario, a network access point enhances the process.

In the appended figures, similar components and/or features may have the same reference label. Where the reference label is used in the specification, the description is applicable to any one of the similar components having the same reference label.

DETAILED DESCRIPTION

The ensuing description provides preferred exemplary embodiment(s) only, and is not intended to limit the scope, applicability or configuration of the disclosure. Rather, the ensuing description of the preferred exemplary embodiment(s) will provide those skilled in the art with an enabling description for implementing a preferred exemplary embodiment. It being understood that various changes may be made in the function and arrangement of elements without departing from the spirit and scope as set forth in the appended claims.

Specific details are given in the following description to provide a thorough understanding of the embodiments. However, it will be understood by one of ordinary skill in the art that the embodiments may be practiced without these specific details. For example, circuits may be shown in block diagrams in order not to obscure the embodiments in unnecessary detail. In other instances, well-known circuits, processes, algorithms, structures, and techniques may be shown without unnecessary detail in order to avoid obscuring the embodiments.

Also, it is noted that the embodiments may be described as a process which is depicted as a flowchart, a flow diagram, a data flow diagram, a structure diagram, or a block diagram. Although a flowchart may describe the operations as a sequential process, many of the operations can be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process is terminated when its operations are completed, but could have additional steps not included in the figure. A process may correspond to a method, a function, a procedure, a subroutine, a subprogram, etc.

When a process corresponds to a function, its termination corresponds to a return of the function to the calling function or the main function.

Moreover, as disclosed herein, the term "storage medium" may represent one or more devices for storing data, including read only memory (ROM), random access memory (RAM), magnetic RAM, core memory, magnetic disk storage mediums, optical storage mediums, flash memory devices and/or other machine readable mediums for storing information. The term "machine-readable medium" includes, but is not limited to portable or fixed storage devices, optical storage devices, wireless channels and various other mediums capable of storing, containing or carrying instruction(s) and/or data.

Furthermore, embodiments may be implemented by hardware, software, firmware, middleware, microcode, hardware description languages, or any combination thereof. When implemented in software, firmware, middleware or microcode, the program code or code segments to perform the necessary tasks may be stored in a machine readable medium such as storage medium. A processor(s) may perform the necessary tasks. A code segment or machine-executable instructions may represent a procedure, a function, a subprogram, a program, a routine, a subroutine, a module, a software package, a class, or any combination of instructions, data structures, or program statements. A code segment may be coupled to another code segment or a hardware circuit by passing and/or receiving information, data, arguments, parameters, or memory contents. Information, arguments, parameters, data, etc. may be passed, forwarded, or transmitted via any suitable means including memory sharing, message passing, token passing, network transmission, etc.

In one embodiment of a controlled return link, a hub can monitor data to and from network servers and proactively allocate additional channel capacity to users who are anticipated to transmit further related requests. The following description uses the exemplary application of an Internet web browser using HTTP to connect to Internet servers as an illustrative embodiment of the present disclosure. It can be appreciated that the present disclosure applies to all types of applications employing any of a number of network protocols, as will be clear from the following description.

When a client (user) browser requests a base file for a web page, the server responds with a file that contains references to in-line objects such as image files that are also part of the page. The client's locally stored cookies, however, may affect what actual objects will end up getting displayed to the client. For example, unique ads or customizations may be made for the particular client. This is one reason why simply applying a pre-fetching system can yield unsatisfactory results. The forward communication link, the hub, the user access point, the Internet, and the network server are all used unnecessarily should pre-fetching gather unneeded information. The client then has to request the needed information anyway since the pre-fetch doesn't gather useful information.

The environment of the disclosure is shown in FIG. **1**. One or more individual or user sites **104** are connected to a common hub or network access point **120** over a long delay link **116**, for this example, a satellite link **116**. The hub **120** is a central location that serves a gateway function for the individual sites **104** and transmits information to the individual sites **104** either in a common channel or through individual channels in what is called the forward direction. In this example, the forward direction is from the hub **120**, through the satellite relay **116** and to the individual sites **104**. The hub **120** either directly or indirectly controls the link usage of the individual sites **104**, which transmit in what is called the return direction, through the relay satellite **116** and to the hub **120**.

At the individual site **104** shown (one of many that may be served by the hub **120**), a number of computers **108** (of potentially different operating systems and configurations) are connected through Ethernet to a user access point **124** that has a satellite modem and includes a number of functions such as network router, etc. The hub **120** is a network access point that relays information between the various users and servers **112**, **128** of interest to those users, the examples given here and any other servers **112**, **128** available to the users through the network access point **120**.

The hub **120** controls the long delay return link by allocating return channel capacity to users based on some algorithm. This allocation can be tightly controlled such as TDMA reservation, mixed reservation/contention, or as loosely controlled as a completely contention based system. Even in a contention-based system, however, some sort of throttling mechanism is typically employed to keep the network from overloading. Note that the general problem of reserving return channel capacity is a system specific design task that is not detailed in this description, since the subject disclosure can be employed on any sort of controlled return channel.

The return channel allocation algorithm typically distributes the return channel capacity among users as a function of their priority (e.g., Quality of Service guarantees) and/or their historic usage. In general, a small amount of capacity is reserved for each individual site **104** so that they can at least request more capacity, although these requests can also be accommodated in a contention channel. Due to the random and bursty nature of network accesses, it is difficult to accurately predict the amount of return channel capacity required by an individual site **104**. If an individual site **104** is allocated too much return channel capacity, then it will be able to quickly make any network requests required, but the excess return channel capacity will not be available to other users, resulting in unnecessary delays for them. If not enough return capacity is allocated to an individual site **104**, then it will make its requests slowly and/or use the long delay link **116** to request greater capacity.

In accordance with the disclosure, a gateway function within the hub **120** monitors the data that flows between individual sites **104** and servers **112**, **128**. With reference to FIG. **2**, a high-level block diagram of the portion of the hub **120** that is relevant to this description of the disclosure is shown. Note that functions such as allocation of the forward channel, etc. are not included for clarity.

The receiver **210** demodulates the incoming data from the individual sites **104**, extracts the outgoing network traffic and forwards it to a network parser **212**. The size of the data received from the individual site **104** is also passed on to a need estimator **214**, which for example maintains a simple channel usage history of the individual site **104** and delivers the future need estimate to a return channel allocator **216**. In this exemplary implementation, the return channel allocator **216** uses the forward channel transmitter **218** to notify the modems **124** at individual sites **104** of their allocation, although other techniques such as side channels, etc. could alternatively be employed.

Continuing to follow the path of network traffic in FIG. **2**, the network parser **212** forwards traffic, such as HTTP page requests or other traffic destined for a network **122**, to the router **220**, which fulfills the requests via the network **122**, for example, the Internet. The router **220** also delivers the traffic received from the network **122** to a site parser **224**, which analyses the traffic and forwards the data on to the transmitter **218** for delivery to the appropriate individual sites **104**.

In one embodiment, a request-based need estimator **226** of the gateway function determines from incoming page requests (from the client at the individual site **104**, forwarded from the network parser **212**) an estimate of the anticipated future requests of that client. This estimate is then sent to the return channel allocator **216**. This estimate can be based, for example, on keeping a table (either by client or globally) with columns for page (or possibly just for the page server's domain) and expected usage. The table values can be updated in any number of ways. For example, the table could be updated each time a page is accessed, typically employing a smoothing filter that biases toward recent activity.

In one embodiment, a response-based need estimator **228** determines from server page files (i.e., requested pages coming from the server **112**, delivered from the site parser **224**) an estimate of the anticipated future requests of that client, which is then sent to the return channel allocator **216**. This estimate can be based on references to in-line elements contained in the response. This can yield an estimate of the future return channel needs, but the gateway function waits for the page request to be filled before making the estimate in this embodiment.

FIG. **3** is an exemplary flow chart of the operation of one embodiment of the disclosure of the gateway function in the hub portion. The depicted portion of the process starts in step **304** upon receipt of a data request, in this example, a web page request from an individual site **104**. The request is, of course, forwarded on to the network **122**, although not shown in this flow chart. If the page request is new in that the uniform resource locator (URL) or a portion of the URL cannot be matched to another URL as determined in step **308**, then a new page history is opened for the requested page in step **316**. In some embodiments, URLs may be deemed to match where there isn't an exact match as metadata in the URL can cause matching to be difficult. Note that the page history is subject to time-out for a number of reasons including limited storage space at the gateway. Obviously, older page histories are less relevant and would be targeted for replacement if there were a table space allocation issue, although certain high priority clients and/or servers **112** and their associated page histories could be maintained as desired. When a page history times out, it is removed from a table or database holding the page history.

If a new page history is opened, then a default return channel need profile is generated. This profile could be null, but would ideally represent a level of need that would give an individual user a reasonable level of service without overloading the return channel if a large number of users were granted the capacity simultaneously. The level of need could be an average for the domain of the URL, a portion of the URL and/or all domains. The sole table shows allocation for particular pages. In this simplified example, profiles for four web pages are stored such that requests for those pages results in an increase in the allocation for the return direction to service the requests likely to follow the web page.

TABLE

Allocations for Pages

Web Page	Allocation in Kbps
realure.com/acme.htm	30
nesbittea.org/contact.htm	80
lucenarity.info/sitemap.htm	10
videodlserver.com/spec.html	200

If the page request is not new, then a page history already exists and is looked up in step **312**. This history can be of a number of equivalent forms: average bit rate needed versus time, specific burst times and sizes, etc. Page histories can be maintained on an individual user basis, individual site basis and/or system-wide. For example, the system-wide average return channel capacity requirement could be employed for a user upon first viewing of a web page that had previously been visited by other users. As the user continues to revisit the page, the usage history would then determine the allocation required.

The estimated needs for the subject individual site **104** is modified in step **320** by the estimate derived above. This estimate is then input into the return channel allocation algorithm and added to the allocation for the individual site **104** in step **328** if the capacity is available on the return channel (RC) as determined in step **324**. This embodiment may wait for the web page to be returned to the hub **120** before modifying the RC allocation for the individual site **104** or could have the change become effective at a time relative to when the user access point **124** receives the web page, but other embodiments could send a message to the modem **124** to increase the RC allocation once the request is correlated to others. One embodiment tries to predict when the return channel will receive the requests for the in-line objects and has the RC allocation timed to coincide with that event. Note that any of a number of known techniques can be used to allocate the capacity, as mentioned previously.

FIG. **4** is a flow chart of an embodiment that uses a response-based need estimator **228** to determine from server page files (i.e., requested pages coming from the server **112**, delivered from the site parser **224**) an estimate of the anticipated future requests of that client, which is then sent to the return channel allocator **216**. After data is received from the server **112** in step **404**, it is relayed on the forward satellite channel to the client modem **124**. The page is also parsed by the site parser **224** in step **408** to determine if there are any in-line objects, etc. that indicate potential user return channel needs in step **412**. A typical application of the algorithm would be to count the number of inline items, estimate the return channel capacity needed to request each one, and then total the estimates. The needs table for that individual site **104**, discussed previously, would then be updated accordingly in step **416**. Finally, as in the previous embodiment, the needs for this individual site **104** would be integrated together with the needs from all the other sites **104** to determine the return channel allocation in steps **420** and **424**. For example, a large need of one individual site **104** may not be completely allocated where other sites **104** are consuming a large portion of the channel.

FIG. **5** depicts data flows for a transaction in which conventional techniques are used to obtain a base HTTP page with two in-line elements. Message transfers are depicted by lines that slope downward with the flow of time where the longer a transfer takes the steeper its slope. The process starts with a user requesting a base page in step **504**, which goes across the long-delay satellite link **116** to the network access point or hub **120**. Note the significant slope of the 'HTTP GET BASE' line **504**, because of the delay of the link **116**.

The network access point **120** then quickly obtains the resulting page from the network **122**, depicted by the looping line that returns quickly (in a short distance down the page) to the network access point **120**. The network access point **120** then forwards the base page from the server **112** to the user in step **508**, again on the long-delay link **116**.

In this example, the user only has capacity to request a single item per round-trip period, so after a short processing delay, the user requests the first in-line element of the base page via the 'HTTP GET IN-LINE 1' request **512**. The network access point **120** then quickly obtains the resulting in-line element from the network, depicted by the second looping line that returns quickly (in a short distance down the page) to the network access point **120**. The network access point **120** then forwards the in-line element to the user in step **516**, again on the long delay link **116**. After a short processing delay, the user requests the second in-line element of the base page via the 'HTTP GET IN-LINE 2' request **520**. The network access point **120** then quickly obtains the resulting in-line element from the network, depicted by the third looping line that returns quickly (in a short distance down the page) to the network access point **120**. The network access point **120** then forwards the in-line element to the user in step **524**, again on the long delay link **116**.

Note that in this example, even if the user were able to request additional capacity from the network access point **120**, any response would not arrive much before the first in-line element, thus making the request moot, since after arrival of the first in-line element, the user would be able to request the second and final in-line element anyway. The web browser or other application software of the user's computer **108** renders the base page and in-line elements as they are received.

FIG. **6** depicts the same transaction as FIG. **5**, except in this scenario, the network access point **120** is able to accurately estimate the user's need to request in-line elements, through request-based and/or response-based need estimators **226**, **228**. Here as in FIG. **5**, the user request **504** is made at the upper left corner of the figure. Once the base page is received by the network access point **120** in step **504**, however, the network access point **120** detects the referenced in-line elements and sends an additional message **612** to the individual site **104**, increasing the return channel allocation for the anticipated requests. Both 'HTTP GET IN-LINE' requests **616**, **620** are then sent subsequently via the increased return channel capacity. The requests **616**, **620** are forwarded on to the Internet **122** by the network access point **120** and fulfilled shortly thereafter. Finally, both in-line elements are delivered to the user. In this illustrative example, approximately one round trip delay time (from the user to the network access point **120** and back) is saved versus the technique of FIG. **5**.

The example illustrated in FIG. **6** is greatly simplified. As a particular modem or user access point **124** can service a number of computers **108** and devices making content requests from the network. The content requests from the individual site **104** are each analyzed and the additional return allocation is communicated to the modem **124**. In this way, the content requests are aggregated to step-up or step-down the return allocation for each modem **124** in the system.

The techniques described herein may be implemented by various means. For example, these techniques may be implemented in hardware, software, or a combination thereof. For a hardware implementation, the processing units within a hub **120** or a modem **124** may be implemented within one or more application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, controllers, micro-controllers, microprocessors, other electronic units designed to perform the functions described herein, or a combination thereof.

For a software implementation, the techniques, processes and functions described herein may be implemented with modules (e.g., procedures, functions, and so on) that perform the functions described herein. The software codes may be stored in memory units and executed by processors. The memory unit may be implemented within the processor or external to the processor, in which case it can be communicatively coupled to the processor via various means as is known in the art.

While the principles of the disclosure have been described above in connection with specific apparatuses and methods, it is to be clearly understood that this description is made only by way of example and not as limitation on the scope of the disclosure.

What is claimed is:

1. A satellite communication system for providing network access over a shared satellite communication link, the satellite communication system comprising:

a user access point comprising hardware coupled to one or more user terminals that access a remote network;

a network access point comprising hardware coupled to the remote network; and

a satellite communications link wirelessly coupling the user access point and the network access point, wherein:

the satellite communications link is at least partially controlled by the network access point,

the network access point monitors information passed between the remote network and the user access point on a per web page basis to create an estimate of future usage of the satellite communications link by the user access point based on the information,

the network access point allocates satellite communications link return channel resources for the user access point based on the estimate when the network access point receives a future request for the web page in anticipation of return channel needs for additional information associated with the web page, and

the estimate is developed from a plurality of web page requests to be biased toward recent requests.

2. The satellite communication system for providing network access over the shared satellite communication link as recited in claim **1**, wherein the estimate includes varying return channel need over a time frame, such that the estimate predicts when the user access point will request the additional information associated with the web page.

3. The satellite communication system for providing network access over the shared satellite communication link as recited in claim **1**, wherein the estimate of future usage is based upon past requests from other user access points.

4. The satellite communication system for providing network access over the shared satellite communication link as recited in claim **1**, wherein the estimate is based, at least in part, on a similarity between a plurality of requests in the information.

5. The satellite communication system for providing network access over the shared satellite communication link as recited in claim **1**, wherein:

the information includes a request and a response to the request, and

the response can be used to estimate the number of future requests.

6. The satellite communication system for providing network access over the shared satellite communication link as recited in claim **1**, wherein the allocation is communicated to the user access point to allow increasing bandwidth from the user access point to the network access point.

7. The satellite communication system for providing network access over the shared satellite communication link as recited in claim **1**, wherein the information includes a web page request contained in said information that, at least in part, affects the estimate.

8. A method for allocating resources over a scheduled return channel of a shared satellite communication link, the method comprising:

receiving a web page request from the shared satellite communication link;

correlating the web page request to similar web page requests made previously;

determining satellite communication link resources used for similar web page requests, wherein the resources are determined from a plurality of the similar web page requests;

predicting an allocation of return link resources adequate to service the web page request based, at least in part, on the determining step; and

changing an allocation of resources associated with the web page request overtime to be biased towards recent requests.

9. The method for allocating resources over the scheduled return channel of the shared satellite communication link as recited in claim **8**, wherein the predicted return link resources vary over time in anticipation of further requests of the additional information associated with the web page.

10. The method for allocating resources over the scheduled return channel of the shared satellite communication link as recited in claim **8**, further comprising:

determining if the allocation can be accommodated on the shared satellite communication link; and

reducing the allocation based, at least in part, on the determining if the allocation can be accommodated on the shared communication link.

11. The method for allocating resources over the scheduled return channel of the shared satellite communication link as recited in claim **8**, further comprising:

storing a new entry for the web page request where the correlating step fails, wherein the new entry uses a seed value derived from other web pages for a domain of the web page; and

updating the new entry upon receiving a response for web page request.

12. The method for allocating resources over the scheduled return channel of the shared satellite communication link as recited in claim **8**, further comprising passing the web page request to a network for fulfillment.

13. A machine-readable non-transitory storage medium having machine-executable instructions for performing the machine-implementable method for allocating resources over the scheduled return channel of the shared satellite communication link of claim **8**.

14. A system adapted to perform the machine-implementable method for allocating resources over the scheduled return channel of the shared satellite communication link of claim **8**.

15. A satellite communication system for providing network access over a satellite communication link, the satellite communication system comprising:

a network access point comprising hardware coupled to a network and a user access point comprising hardware, wherein a satellite communications link is used to couple the user access point and the network access point, and further wherein:

the satellite communications link is at least partially controlled by the network access point,

the network access point monitors information passed between the network and the user access point to create an estimate of future usage of a return channel of the satellite communications link by the user access point when a web page is requested,

the estimate is developed from one or more web page requests, and

the network access point allocates satellite communications link resources for the user access point based on the estimate when the web page is requested.

16. The satellite communication system for providing network access over the satellite communication link as recited in claim **15**, wherein the information comprises in-line elements of the web page that, at least in part, affect the estimate.

17. The satellite communication system for providing network access over the satellite communication link as recited in claim **15**, wherein:

the information includes a request for an embedded URL of the web page and a response to the request, and

the response can be used to estimate a number of future requests.

18. The satellite communication system for providing network access over the satellite communication link as recited in claim **15**, wherein:

a first uniform resource locator (URL) is used to identify the web page, and

a future request for the web page uses a second URL that only partially matches the first URL.

* * * * *